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Pavement Forensics
Route 3, Lancaster County, Virginia

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Pavement Forensics

- **Project Number:0003-051-114, C501**
- **Location:WB Route 3, MP 16.10 – 19.10**
- **Lancaster County, Fredericksburg District**
- **White Stone - Kilmarnock**

Background

- **In 1992 the road was widened from a 2-Lane highway to a 4-Lane highway.**
- **The new mainline structure was as follows:**
 - **6 in. Soil Cement**
 - **6 in. Dense graded aggregate (21A)**
 - **3 in. Asphalt Base**
 - **1.5 in. Asphalt Surface Course**
- **Shoulder: 4 in Aggregate Base (21A)**
- **Surface Treatment**
- **Subgrade: A-2-4 and A-3 (Top 2 ft) CBR= 20**

Background

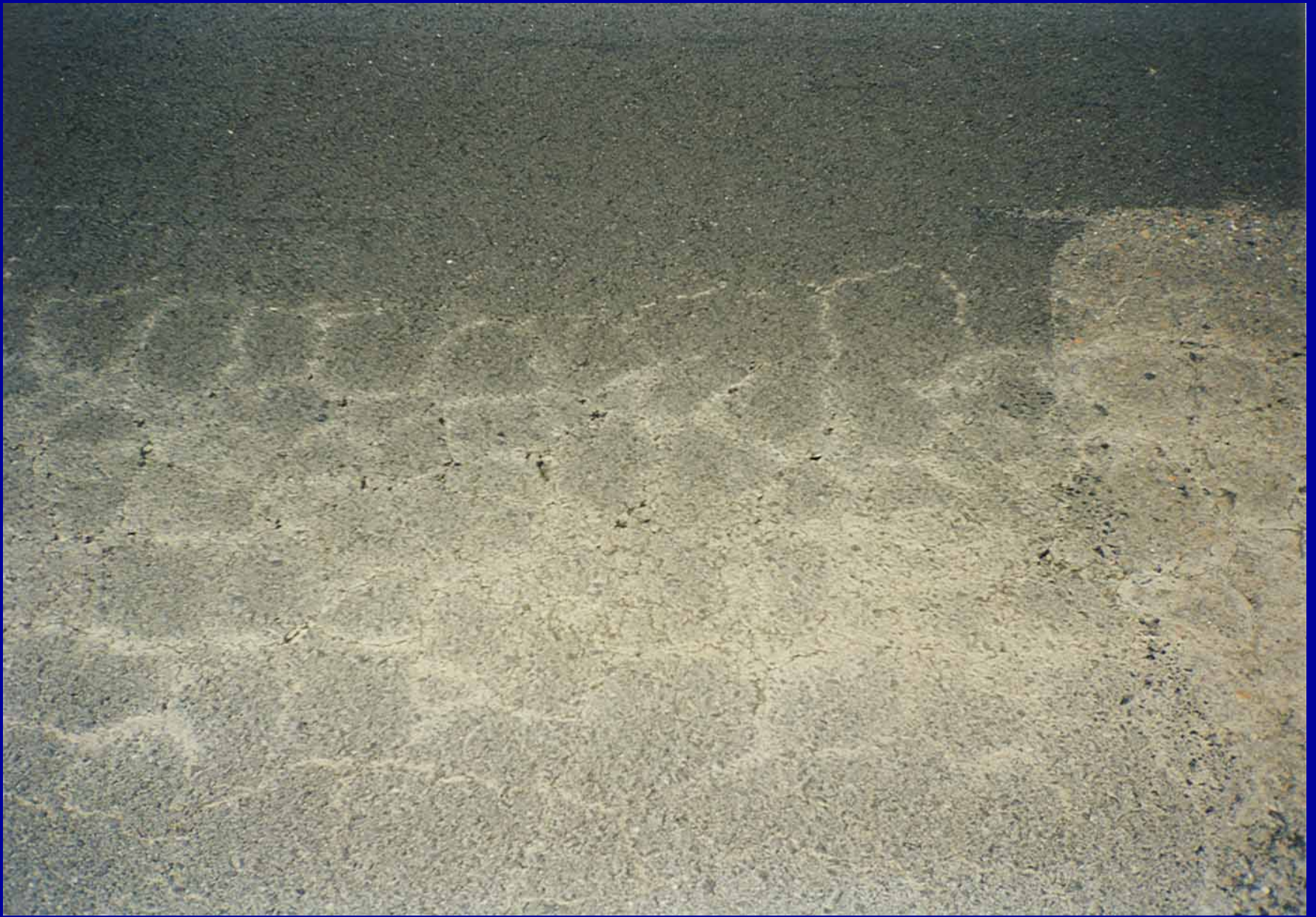
- Traffic
 - **6,000 AADT**
 - **3% Tractor Trailers**
 - **1% Single Unit Trucks**
 - **1997 ESAL = 101**
 - **2015 ESAL = 157**

- **1994-** white stains were evident in the surface layer in isolated spots, no distress was observed
- **1998-** several areas of the travel lane were failing in fatigue and alligator cracking. The asphalt (4.5 inches) was milled and replaced in both lanes
- **1999-** travel lane developed severe alligator cracking in two areas totaling 0.27 miles, the failures were worse than those of 1998











Record Review

- **After seven months the pavement (placed in 1998) began to have alligator cracking**
- **No edge drains were designed for the road**
- **There was a 2 ft. undercut on the roadway during construction in 1992; a geosynthetic mat was used along with imported backfill to bring the roadway back to grade**
- **Roadway occurs in both a cut and fill sections, but most of it in flat areas**

Field Distress Survey:

- **Failure occurred in the right wheel path of the truck lane**
- **Failure occurred in the lower part of super-elevated and transition area**
- **Surface course appeared to be relatively porous**
- **Right wheel path and left wheel path had some discoloration**
- **2.75 miles of the pavement of the pavement were serviceable**
- **0.25 miles of the pavement was patched at full depth to the soil cement**

Structural Evaluation:

- **AC pavement was wet at the layer interfaces**
- **Fines were found in the base AC samples along with discoloration**





Field Sampling and Testing:

- **FWD testing was done to gather deflection data from the pavement structure and the subgrade**
- **Cores were taken based deflection values obtained from the FWD testing to correlate deflection data with pavement structure/distress**
- **Aggregate subbase samples were taken by removing the asphalt layers using a roller blade cutter**









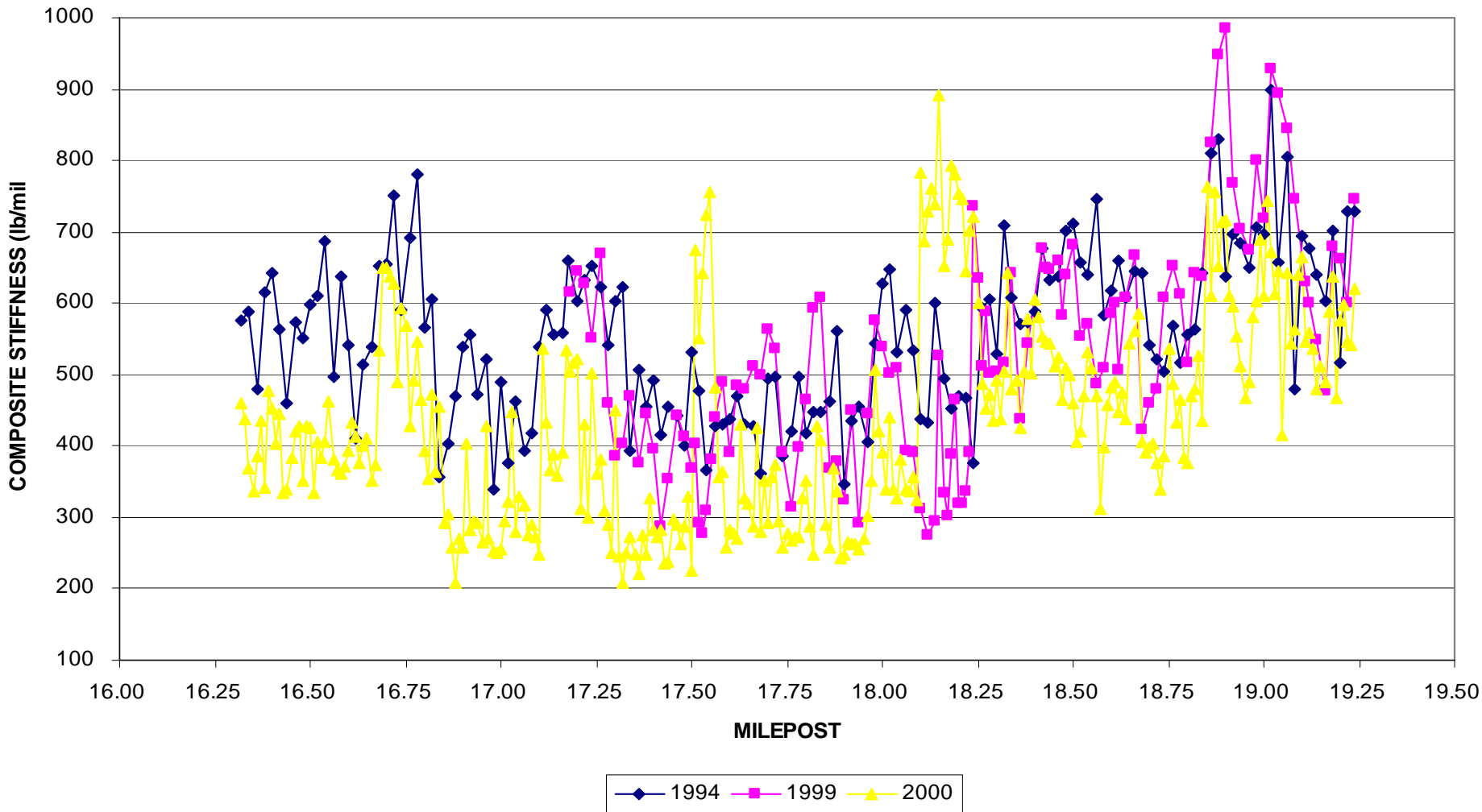


FWD Testing:

- **The composite stiffness versus station was plotted for 1994, 1999, and 2000 using the FWD deflection data**
- **An average composite stiffness of 500 lbf/mil for all years were obtained, which entails that little to no improvement was made between 1994 ,1999, and 2000**



Rte. 3 Lancaster Co.
COMPOSITE STIFFNESS PROFILE
(Travel Lane)



Average Stiffness	1994 -	558 lb/mil
	1999 -	528 lb/mil
	2000 -	439 lb/mil



Laboratory Testing:

- **The Core data showed that pavement densities in the outside wheel path and the inside wheel paths were different.**
- **The top layer was less dense (89.5%) than the base layers (91.2%)**
- **The total voids in the surface AC samples in the area of failure averaged 14.9%**
- **The total voids in the base AC samples in the area of failure averaged 10.6%**

- **The 21A Aggregate subbase , top of subbase sample, and shoulder sample were out of spec for four sieves and contained mica, with 18% passing the 200 sieve.**
- **All Asphalt layer samples passed on gradation.**

Pavement Failure Mechanism

- The low density of the asphalt surface and base layers in the travel lane allowed water infiltration to the 21 A aggregate subbase.
- The 21A aggregate had 18% fines.
- The paved shoulder had also similar high fines.
- The 21A aggregate subbase didn't drain properly. It stored water, which led to substantial decrease in its strength.

- **The weakest area of the AC layers was the outside wheel path of the travel lane.**
- **Combination of water entrapment and non-structurally sound AC resulted in the accelerated pavement deterioration in a fatigue mode.**

Rehabilitation Options

- a) **Mill surface and base AC layers, cement stabilize the existing 6 in of 21A aggregate in-place, place 4.5 in. of AC base, then place 1.5 in Ac surface for both lanes. Install pavement edge drains**
- b) **Place a 1.5 in. AC surface course to both lanes to seal and add structural strength**
- c) **During a dry period, let the existing 21A aggregate layer dry, and seal both lanes with latex slurry seal to keep water from infiltrating**

Rehabilitation Options

Option	Total Cost	Life Years	Public time Loss	Comments
a	\$894,000	20	1 in 30 yrs.	High Initial Cost
b	\$111,000	4	7 in 30 yrs.	Wet, poor 21-A remains
c	\$54,000	2	15 in 30 yrs.	Buys Time as you go









Lessons Learned

1. **When the distresses are severe to the point where a decision to be made for extensive rehabilitation, then field investigation should be in relative proportion to it.**
2. **Before making the final decision be sure to identify the failure mechanism so it can be addressed in the rehabilitation.**

Lessons Learned

3. The lack of density of the Asphalt concrete mix allowed water to infiltrate into the aggregate subbase, so coring and density determination could have explained how water entered the pavement, and avoided making the wrong decision in 1998.
4. At the time of milling of the asphalt in 1998, the condition of the aggregate layer should have been evaluated for suitability in the pavement structure. High fines traps water and acts like a sponge, leading to pumping and eventual failure.

Lessons Learned

5. **Non-destructive testing and field forensic work should complement each other for best results.**
6. **Cooperation between the field personnel and Central Office pavement design resulted in most economical rehabilitation and excellent pavement performance.**
7. **For 5 years no maintenance was needed, although the truck traffic increased in the past 2 years.**

Thank You

